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Survival and growth of red pine populations in Manitoba 15 years after planting

by J. I. Klein

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ABSTRACT

A red pine provenance test plantation was established near Piney, Manitoba in May 1958 with five populations originating in Ontario and one population each from Manitoba, Michigan, Quebec, New Brunswick, and Nova Scotia. Survival varied widely among populations by August 1960, and condition of the trees prior to planting may have been a contributing cause of this variation. There were no significant differences among populations in survival to 1973 of trees alive in 1960. The population from Regina Bay in northwestern Ontario was tallest in 1973, followed by the local and Raco, Michigan populations. The superiority of Regina Bay over the local population was judged insufficient to justify any change from the current practice of using local seed for planting of red pine in southeastern Manitoba. Results from this plantation do not support new seed source tests with red pine in southeastern Manitoba.

RÉSUMÉ

Par plantation, on testa des provenances de Pin rouge (P. resinosa) en mai 1958 près de Piney, Manitoba; on avait importé cinq populations de l'Ontario et une chacune du Manitoba, du Michigan, du Québec, du Nouveau-Brunswick et de la Nouvelle-Ecosse. Arriva août 1960, et le taux de

survie avait varié beaucoup parmi les populations: la condition des arbres avant la transplantation avait peut-être causé cette variation. Aucune différence significative de survie parmi les populations de 1960 à 1973 ne fût observée. La provenance de Regina Bay dans le nord-ouest de l'Ontario devint la plus haute en 1973, suivie des arbres locaux et de ceux de Raco, Michigan. La supériorité de Regina Bay sur les arbres locaux ne se révéla pas suffisante pour justifier son adoption à la place des arbres du sud-est du Manitoba. Les résultats obtenus ne soutiennent pas de nouveaux tests de provenances pour ce qui concerne le pin rouge dans le sud-est du Manitoba.

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INTRODUCTION

A provenance test plantation was established near Piney, Manitoba in May 1958 with 4-yr-old red pine (Pinus resinosa Ait.) transplants of nine populations reared at Petawawa Forest Experiment Station, and red pine seedlings or transplants of local origin reared at Pinelands Provincial Tree Nursery, Hadashville, Manitoba. This plantation is the most westerly element of Petawawa's Experiment No. 96, planted in 10 locations in Canada with varying numbers of a set of 20 populations.

Performance in this plantation to August 1967 has been reported by Roller (1968). He found that a population from Raco, on Michigan's upper peninsula, had outstanding survival and was second best in height. The best growth was produced by a population from Regina Bay in northwestern Ontario, which had only average survival. The local population survived well and showed good growth from 1963 to 1967, but ranked near bottom in total height. Of the remaining populations, those from Ontario were generally better than those from eastern Canada. Results from the 10 plantations in the series did not reveal any population with superior performance at most locations (Holst 1975).

The present report is based on measurements taken in early spring of 1973, 5 yr after the previous measurement and 15 yr after planting, together with certain older data. Roller (1968) stated that 46% mortality occurred during the first growing season, but presented

population mortality data only as cumulative mortality to 1967. In view of the heavy mortality which occurred immediately after planting, an attempt is made here to discriminate between mortality associated with initial reaction to planting and later mortality of trees which were in good condition at the end of the establishment period. August 1960 is considered to mark the end of the establishment period. By then, all of the trees initially scored as living but not healthy had either died or attained good health. Results reported here are survival to August 1960, survival to May 1973 of trees planted and of trees alive in 1960, height in 1973, and height growth to 1973 from August 1967.

MATERIALS AND METHODS

The nine populations reared at Petawawa included five from Ontario and one each from Quebec, New Brunswick, Nova Scotia, and Michigan. The experimental design was randomized block with five replications and 49-tree square plots at 1.2-m spacing. The local population, from Sandilands Provincial Forest, was planted in single rows between plots and in two rows surrounding the plantation. Source of the populations is presented in Table 1 listed from west to east. There is no record of the number of trees furnishing seed for each population. Planting was accomplished by the Manitoba Forest Service, with assistance from the Forestry Branch, Canada Department of Northern Affairs and National Resources.

The planting site, located at 49.1°N, 95.9°W in the Rainy River section of the Great Lakes-St. Lawrence forest region (L 12)

Table 1. Source location[1] and climate[2] for red pine populations planted near Piney, Manitoba[3] in May 1958

Lot No.	Source	°N lat.	°W long.	Mean temp. °C July	Mean temp. °C Jan.	Growing degree-days, °C	Frost-free days	Precip., mm ann.	Precip., mm May - Sept.
	Sandilands Prov. For., Manitoba	49.2	96	19	-17	1530	90	550	360
1717	Regina Bay, Ontario	49.4	94.0	20	-17	1530	120	640	380
1712	Raco, Michigan	46.4	85.1	not readily available					
1716	Sault Ste. Marie, Ontario	46.5	84.0	18	-10	1530	110	840	410
1715	Thessalon, Ontario	46.3	83.5	18	-10	1530	115	840	380
1718	Sturgeon Falls, Ontario	46.3	80.0	19	-11	1530	110	890	410
1714	Petawawa For. Exp. Stn., Ontario	45.9	77.3	20	-12	1670	120	750	360
2114	Kenogami, Quebec	48.3	71.5	17	-16	1110	100	910	480
2046	Grand Lake, New Brunswick	46.0	66.0	19	-10	1530	120	960	420
2045	Stanley, Nova Scotia	45.0	63.0	18	- 7	1390	120	1270	460

[1] Roller (1968) except source longitude of local population cannot be 95.0°W if the population is from Sandilands.

[2] Chapman and Brown (1966).

[3] Plantation located at 49.1°N, 95.9°W.

(Rowe 1972) is essentially flat and covered by a minimal podzol soil developed on excessively drained sand deposits. The site is too dry for good growth of red pine, judging from the dominance of Arctostaphylos uva-ursi L. and the presence of Vaccinium angustifolia Ait. and Prunus pumila L. in the lesser vegetation (Mueller-Dombois 1964). Climate is characterized by mean temperatures of 19°C and -17°C for July and January respectively, a 90-day frost-free season, 1530 growing degree-days above 5.6°C, annual precipitation of 550 mm, and May to September precipitation of 360 mm (Chapman and Brown 1966).

Observations were made on the complete 49-tree square plots for the non-local populations. Plot values for the local population were derived from the eight, seven-tree rows between the nine square plots of a block. Survival percentages for each plot were transformed into arcsines prior to analysis. Analysis of height and height growth was performed on unweighted plot means. Mean height growth for each plot was computed from trees alive in 1973, and hence is not identical to the change in plot mean height from 1967 to 1973. Two-way analysis of variance and Duncan's New Multiple-Range Test were applied at the 5% probability level.

RESULTS AND DISCUSSION

Population means and the outcome of statistical analysis of survival and growth are presented in Table 2. Survival percentages in Table 2 were obtained by reverse transformation of population mean arcsines.

Table 2. Survival and growth of red pine populations planted near Piney, Manitoba in May 1958

Source	Survival, %[1] Aug. 1960	1973 ÷ 1960[2]	May 1973	Height, cm May 1973[3]	Height growth, cm Aug 67 to May 73[3]
Sandilands	95	64 a[4]	61	229 ab (ab)	101 a (ab)
Regina Bay	58 bcd	89 a	52	247 a (a)	103 a (a)
Raco	97 a	82 a	79	223 abc(ab)	82 ab (abc)
Sault Ste. Marie	52 cd	74 a	42	198 bcd(bc)	68 abc(bcd)
Thessalon	76 bc	70 a	54	201 bcd(bc)	66 abc(cd)
Sturgeon Falls	32 de	82 a	30	168 d -	28 c -
Petawawa	83 ab	68 a	57	183 cd (c)	52 bc (cd)
Kenogami	21 e	85 a	18	174 d -	39 bc -
Grand Lake	68 bc	70 a	46	168 d (c)	45 bc (d)
Stanley	17 e	75 a	14	171 d -	52 bc -
Mean	58[5]	76	46	196 (208)	64 (74)
F-ratio[6]	9.42*	<1		4.08*(5.77*)	2.94* (4.83*)
No. differences	21			16 (8)	11 (8)

[1] Percentages obtained by reverse transformation of population mean arcsines.

[2] Based on number of trees alive in 1973 divided by number alive in 1960.

[3] Analysis results when populations with fewer than 100 surviving trees are excluded are in parentheses.

[4] Means in the same column with a common letter are not significantly different at the 5% level.

[5] Excluding Sandilands.

[6] * = significant at the 5% level.

SURVIVAL

Survival to August 1960 ranged from 17% for Stanley to 97% for Raco. The mean for the nine populations reared at Petawawa was 58%. Sandilands, with 95% survival, was excluded from the analysis owing to the possible influence of its different rearing history on initial survival. Twenty-one pair differences were found significant by the multiple-range test. Raco had significantly better initial survival than seven of the eight populations which ranked below it. Even the sixth-ranked population, with 52% survival, was superior to the two populations having the poorest survival. Populations other than Raco surviving no worse than average were Petawawa (83%), Thessalon (76%), Grand Lake (68%), and Regina Bay (58%).

Population differences for survival to 1973 of trees alive in 1960 were not statistically significant. Sandilands was included in the analysis for this period. Mean survival for the plantation was 76% ranging from 64 to 89% for the populations.

The occurrence of most of the mortality before the first examination of the plantation creates some doubt as to whether the trees which died by August 1960 were in good condition when they were planted. The absence of significant inter-population differences in survival of initially healthy trees from 1960 to 1973 does nothing to remove this doubt. Consequently, the survival results are less valuable in drawing conclusions than might have been the case if

differences in survival had appeared after, rather than before, the first post-planting examination. In the other plantations of this series survival was generally high and not significantly different among populations (Holst 1975).

HEIGHT GROWTH

Height in May 1973 averaged 196 cm for the plantation, and population means ranged from 168 to 247 cm, or 40% of the plantation mean. Regina Bay was significantly taller than seven of the nine populations which ranked below it. Sandilands, second in rank, was taller than five populations, and Raco was taller than four populations. The fourth-ranking population, Thessalon, was not significantly taller than the shortest population.

Growth in height from August 1967 to May 1973 (five growing seasons) averaged 64 cm and ranged from 28 to 101 cm. The two top-ranking populations, Regina Bay and Sandilands, outgrew the five slowest growing populations. Raco, third in rank, grew faster than the last-ranked population.

Inspection of the data suggested that plots with fewest surviving trees were contributing excessively to error variance in the height and height growth analyses. The analyses were therefore repeated, excluding the three populations which had fewer than 100 trees surviving out of 245 planted, in order to increase the sensitivity of comparisons among the remaining populations. The excluded populations

(Sturgeon Falls, Kenogami Lake, and Stanley) happened to be inferior in growth.

The new analysis resulted in additional differences in height and height growth among the remaining populations. The height superiority of Raco over Petawawa gained significance. For height growth, additional significant differences were Regina Bay over Sault Ste. Marie and Thessalon, Sandilands over Thessalon, and Raco over Grand Lake.

A geographic frame of reference may be useful in summarizing results for height and height growth. Regina Bay and Sandilands, originating from near the northwestern margin of the species' range, are both superior in height and height growth to the three easternmost sources in the test (Kenogami Lake, Grand Lake, and Stanley), and to the two eastern sources (Sturgeon Falls and Petawawa) in the transect of five sources at about 46°N, running from 85.1 to 77.3°W. In addition, Regina Bay is superior to Sault Ste. Marie and Thessalon, originating 1.1 and 1.6° east of Raco. Raco, at the western end of the 46°N transect, is superior to the five eastern populations in height, but only to Sturgeon Falls and Grand Lake in height growth.

Compared with the results reported by Roller (1968), Sandilands has improved from second last to second best in height. The height growth rate of Sturgeon Falls deteriorated sharply, causing it to drop from third to last rank in total height. Raco was displaced from second rank in height by Sandilands, and has fallen farther behind in height growth relative to Regina Bay and Sandilands.

The tested populations, except for Sandilands, were planted at other locations in Canada. Regina Bay was not outstanding in height at 10 yr after planting in any other location. It was last in rank in a plantation near Dryden, although that plantation is closer to its source than is the Piney plantation. Raco was tallest in a plantation near Swastika in northeastern Ontario, where the climate is slightly more humid than in southeastern Manitoba, but the temperature regime is similar. The three easternmost populations showed poor performance in other plantations, as they did at Piney (Holst 1975).

CONCLUSIONS

The non-significant 8% height advantage of Regina Bay over Sandilands is not a sufficient basis for recommending the operational use of a non-local seed source as a means of increasing productivity. Regina Bay grew only 5 cm more than Sandilands from 1963 to 1967 (Roller 1968), and 2 cm more from 1967 to 1973. Most of its present 18-cm height advantage thus dates to the first 5 yr after planting, when rearing conditions could have exerted a considerable influence on growth. The poor performance of Regina Bay near Dryden and its unimpressive early survival provide further grounds for caution. Despite the excellent early survival and comparatively good growth of Raco, there is no reason to recommend its use in southeastern Manitoba in the face of the better growth and satisfactory survival of the local population. Results from the Piney plantation to date thus appear to support continued use of local seed for planting of red pine in southeastern Manitoba.

Results from the Piney plantation provide only marginal guidance on the prospective value of new red pine provenance tests in southeastern Manitoba. The performance of Regina Bay and Raco indicates a good likelihood of finding populations roughly equal in productivity to the local population. Such an outcome would, however, be of questionable practical significance. The likelihood of finding populations of superior productivity remains a speculative question. These results suggest that if there are superior populations, they are more likely to be found in the western than the eastern half of the species' range.

Justification for continued maintenance and remeasurement of the Piney plantation lies mainly in the value of information on correlation of early performance with long-term performance that will be obtainable from the plantation in due course. Such information would be useful if new red pine provenance tests are initiated in southeastern Manitoba in the future. As the Piney plantation is part of a 10-plantation experiment, its continued maintenance will be of interest for performance comparisons between locations. There is little likelihood that long-term results will provide more support for operational use of non-local populations in southeastern Manitoba than do the results reported here.

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